

1 **HIV testing and engagement with the HIV treatment cascade among men who have**
2 **sex with men in Africa: A systematic review and meta-analysis**

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37 **ABSTRACT**

38 **Background**

39 HIV disproportionately affects gay, bisexual, and other men who have sex with men (MSM)
40 in Africa, where many countries criminalise same-sex behaviour. We assessed changes in
41 the engagement of African MSM with HIV testing and treatment cascade stages over time,
42 and the influence of anti-LGBT legislation and stigma.

43 **Methods**

44 We systematically searched the peer-reviewed literature to October 10th, 2018 for studies
45 and extracted or derived estimates of HIV testing and/or engagement with the HIV treatment
46 cascade among African MSM from published reports. We derived pooled estimates using
47 inverse-variance random-effects models. We used subgroup and meta-regression analysis
48 to assess associations between testing and status awareness outcomes and study and
49 participant characteristics including the severity of country-level anti-LGBT legislation.

50 **Findings**

51 Our searches identified 75 independent eligible studies that provided estimates for 44,993
52 MSM across one or more of five testing and treatment cascade outcomes. HIV testing
53 increased significantly over time overall, with pooled overall proportions of MSM ever tested
54 of 67·3% (95%Confidence interval 62·1-72·3%,N=44) and tested in the past 12 months of
55 50·1% (42·4-57·8%,N=31) post-2011 – 14% and 18% points higher than pre-2011,
56 respectively. Post-2011, ever testing was highest in Southern(80·0%) and lowest in
57 Northern(34·4%) and Central(56·1%) Africa, with the greatest increase in Western
58 Africa(from 42·4 to 70·9%). Levels of both testing outcomes and status awareness were
59 statistically significantly lower in countries with the most severe anti-LGBT legislation.

60 Few estimates were available for later stages of the treatment cascade. Available data post-
61 2011 suggest that the pooled proportion of MSM HIV-positive aware has remained low
62 (18·5%, 12·5-25·3%,N=28) whereas proportions of current ART use were 23·7% (15·5-
63 33·0%,N=14) among all MSM living with HIV and 53·4% (36·9-69·5%,N=6) among MSM
64 HIV-positive aware. Levels of viral suppression among MSM currently on ART were good
65 (pooled: 75·6%, 64·4-85·5%,N=4), but low among all MSM living with HIV (pooled: 24·7%,
66 18·8-31·2%,N=4).

67 **Interpretation**

68 Available data suggests that levels of HIV status awareness among MSM living with HIV in
69 Africa remain low, despite recent improvements in HIV testing; limited data is available on
70 levels of engagement in care, ART use and viral suppression. We found that severe anti-
71 LGBT legislation was associated with lower HIV testing and status awareness. Achieving
72 UNAIDS 90-90-90 targets will require substantial improvements.

73 **Funding**

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75 INTRODUCTION

76 The development of highly active antiretroviral therapy (ART) in the 1990s transformed HIV
77 from a fatal infection to a treatable chronic disease.¹ People living with HIV (PLHIV) on
78 suppressive ART can live as long as people without HIV.² However, achieving viral
79 suppression requires engagement in all stages of HIV care, from testing and early diagnosis,
80 through the treatment cascade, including linkage into and retention in care, early ART
81 initiation, and near-perfect adherence.³ Globally, however, ~1 million PLHIV still die from HIV
82 annually because they cannot or do not complete this cascade.^{4,5}

83 UNAIDS has formulated the '90-90-90' targets, aiming to have 90% of PLHIV aware of their
84 status, 90% of PLHIV aware of their status on ART, and 90% of PLHIV on ART achieving
85 viral suppression by 2020,⁶ with targets increasing to 95% by 2030.⁷ Therefore, by 2020 and
86 2030, 73% and 86% of PLHIV should be virally suppressed, respectively.⁷ Engaging PLHIV
87 in the cascade to meet these ambitious targets will have major implications for PLHIV and
88 HIV prevention, improving mortality and morbidity outcomes,⁸ and reducing transmission
89 risk.^{9,10} UNAIDS has highlighted the importance of reaching key populations, including gay,
90 bisexual, and other men who have sex with men (MSM), however estimates of progress
91 towards achieving 90-90-90 targets among MSM are very scarce, which compromises our
92 ability to assess impact, adequately address needs and reduce barriers to uptake of
93 services, and improve HIV prevention services for MSM.^{11,12} Globally, MSM are ~28 times
94 more likely to be living with HIV than men in the general population – an inequality that is
95 particularly apparent in sub-Saharan Africa, where the human rights of MSM are often
96 violated.^{5,13–19}

97 Almost two-thirds of African countries still criminalise same-sex relations, many with long
98 prison sentences and some with the death penalty.²⁰ In this context, stigma, discrimination,
99 and human rights violations of MSM that are linked to legislation have been widely
100 documented.^{5,13–19} This includes blackmail, violence, reprisals from family and communities,
101 denial of housing, healthcare, and access to justice, and lack of adequate and accessible
102 services for MSM.^{21–23} These also create barriers to implementing effective HIV research,
103 policy, and health programmes for MSM, through prohibition of activism and research,
104 arbitrary arrests of healthcare providers, and disruption of services provided by community-
105 based and non-governmental organisations (NGOs).^{24–26} This may also explain why
106 research on African MSM has lagged behind that in other parts of the world.^{15,17,25–28}

107 After South Africa led the first United Nations (UN) resolution on sexual orientation and
108 gender in 2011, some positive changes in lesbian, gay, bisexual and transgender (LGBT)

109 rights protection were reported in parts of Africa, albeit inconsistently.²⁹ For example, while
110 Seychelles, São Tomé and Príncipe, Mozambique and Lesotho have decriminalised same-
111 sex relations, Uganda and Nigeria have increased the severity of their anti-LGBT
112 legislation.²⁰

113 In this study, we (1) systematically reviewed published studies providing estimates of levels
114 of HIV testing, diagnosis, and the treatment cascade among MSM in Africa; (2) assessed
115 whether these outcomes have improved over time; and (3) explored the influence of
116 participant and study characteristics, study quality, and two key structural factors – stigma
117 and severity of anti-LGBT legislation – on each outcome.

118 **METHODS**

119 This systematic review and meta-analysis was reported in accordance with PRISMA and
120 MOOSE guidelines.^{30,31}

121 **Search strategy and selection criteria**

122 We searched Embase, Medline, Scopus, Global Health, and Web of Science for articles
123 reporting on HIV testing and/or any HIV treatment cascade stages in Africa published
124 between January 1st, 1980 and October 10th, 2018 using terms for HIV, MSM, and Africa
125 (see appendix p 1 for full search terms).

126 We screened by abstract and title, then screened potentially relevant full-texts for studies
127 directly reporting estimates or sufficient data to self-calculate proportions of MSM engaging
128 in HIV testing and/or treatment cascade stages. We only included peer-reviewed cross-
129 sectional or longitudinal studies recruiting at least 10 MSM. We excluded mathematical
130 modelling studies, qualitative studies, conference abstracts and reviews, and studies
131 reporting cascade outcomes using self-reported HIV status (instead of confirmed biological
132 test) to derive the number of MSM living with HIV in the denominator. We did not exclude
133 articles based on language.

134 For included studies, we extracted or self-calculated proportions of MSM: 1) who self-
135 reported having ever or recently received an HIV test; 2) testing positive in the study (“MSM
136 living with HIV” hereafter) who self-reported being HIV positive before testing (“MSM HIV+
137 aware” hereafter); 3) living with HIV who self-reported being ever or currently engaged in
138 care or linked to care following diagnosis; 4) living with HIV or HIV+ aware who self-reported
139 ever or currently taking ART; and 5) living with HIV, HIV+ aware, or currently on ART who
140 were virally suppressed (based on viral load testing). We excluded estimates based on
141 fewer than 10 MSM. One of four study authors contacted provided estimates of MSM ever
142 and recently tested and of MSM living with HIV virally suppressed.³²

143 For each study, we extracted information on participant characteristics (e.g. population,
144 region of Africa, HIV prevalence among MSM participants tested in the study, proportion
145 sold sex), stigma (e.g. proportion who disclosed their MSM status to healthcare workers or
146 family, or were blackmailed), study characteristics and quality indicators (e.g. study year,
147 study design, sampling and interview methods).

148 We used country-specific data from International Lesbian, Gay, Bisexual, Trans and Intersex
149 Association (ILGA) reports, country constitutions, and UN reports to construct four

150 composite “anti-LGBT legislation” variables, one global anti-LGBT legislation index, and one
151 “arrests” variable for each study country.^{20,33–35}

152 The four anti-LGBT legislation variables are: repressive legislation (same-sex relations,
153 sexual orientation-related NGOs, or LGBT promotion are illegal, age of consent differs for
154 same-sex relationships, or legislation prohibits same-sex marriage and/or adoption; score 0-
155 5), lack of protective legislation (LGBT people are not protected from discrimination, or
156 incitement to hatred based on sexual orientation is not illegal; score 0-2), lack of progressive
157 legislation (same-sex marriage and/or adoption are not legally recognised; score 0-2), and a
158 penalties variable (the harshest punishment receivable for consensual same-sex relations
159 varying from no punishment to the death penalty; score 0-5). Our global anti-LGBT
160 legislation index summed the scores of these four legislation variables(score 0-14), for each
161 study country at the time the study was conducted. Higher scores reflected less progressive
162 legislation. The binary arrests variable captured if arrests for consensual same-sex relations
163 had been documented in the country between 2014 and 2017 (the only such data
164 available).²⁰ See appendix p 2-3 for additional details.

165 JS, ED, and RS independently performed all stages of screening and data extraction.
166 Discrepancies were resolved by KM.

167 **Data analysis**

168 We pooled independent study estimates and calculated 95% confidence intervals (CI) and
169 95% prediction intervals (PrI) using random-effects models based on the DerSimonian-Laird
170 inverse-variance method and the Freeman-Tukey transformation for proportions³⁶. We
171 provide estimates on the original scale. Heterogeneity across estimates was assessed using
172 the I^2 statistic.^{37,38} Where multiple articles estimated the same outcome for the same study
173 population, we preferentially used estimates from the largest sample, or used the most
174 recent estimates if sample sizes were equal. From these, we preferentially used weighted
175 estimates accounting for clustering (e.g. from RDS studies) over crude estimates, where
176 available (see appendix p 3-4 for details). For studies conducted in multiple locations, we
177 preferentially extracted estimates for separate locations if reported; otherwise we used the
178 combined estimate. For studies reporting on both MSM and transgender women (TGW), we
179 included estimates for MSM alone if disaggregated data were available, otherwise we used
180 estimates from the whole sample.

181 We assessed whether study estimates varied by study year, region, or other study,
182 participant, or structural variables (e.g. population, MSM HIV prevalence, proportion sold

183 sex, stigma, anti-LGBT legislation (see appendix p 21-26 for full list)), and study quality
184 using univariate meta-regression for study outcomes with ≥ 20 estimates. Additionally, we
185 assessed whether time trends differed by region (using a model with region*study year
186 (continuous) interaction) and country if there were ≥ 3 estimates at different time points. If
187 study year was significantly ($p < 0.05$) associated with the outcome in univariate meta-
188 regression, we also conducted bivariate (time-adjusted) meta-regression (adjusting for time
189 as a continuous variable). We presented pooled estimates of outcomes stratified by
190 variables statistically significantly associated in time-adjusted meta-regression in forest plots
191 stratified by study year. We also conducted leave-one-out sensitivity analyses to explore
192 how sensitive associations between ever testing and the global anti-LGBT legislation index
193 were to the exclusion of individual countries and studies.

194 We further assessed study quality using subgroup analysis stratified by pre-defined quality
195 indicators based on the AXIS tool for appraising cross-sectional studies,³⁹ including study
196 design, reporting bias, publication bias, and a quality score summing the responses to three
197 key quality criteria (see appendix p 5). We further assessed publication bias using funnel
198 plots and Egger's test for asymmetry.⁴⁰

199 We conducted all analyses with R 3.5.1 using the metafor package.^{41,42}

200 **Role of the funding source**

201 The funder had no role in study design, data collection, data analysis, data interpretation, or
202 writing of the report. The corresponding author had full access to all the data in the study
203 and had final responsibility for the decision to submit for publication.

204 RESULTS

205 We included 113 articles reporting on 75 independent studies providing estimates (or data to
206 self-calculate estimates) of the testing and cascade outcomes(Figure 1). The number of
207 relevant studies conducted, and articles published, increased markedly from 2007 and 2010
208 onwards, respectively (see appendix p 6).

209 Table 1 summarises the outcomes, participant characteristics, structural variables, and study
210 characteristics of included studies (see appendix p 7-15 for additional details).

211 Most studies provided proportions of MSM ever HIV tested(number of studies [N_s]=54,
212 number of estimates [N_e]=81^{32,43-95} recently tested (N_s=33, N_e=51)<sup>32,43,46,48-51,62,73,76,78,80,82,85,96-
213 109</sup>, and HIV+ aware (N_s=23, N_e=35).^{32,43,48,51,58,62,68,87,88,110-122} Very few studies provided
214 proportions of MSM engaged in care^{68,116,118,123,124} on ART (ever^{48,116,122,124},
215 currently^{32,68,102,116,118,119,125-128}), or virally suppressed^{32,116,122,125,128-130} (Table 1a).

216 Over half the studies were conducted after 2011 (Table 1e). Studies provided estimates for
217 28 countries predominantly from Eastern,^{32,43-61,77,97,108-111,121,122,124,125} Western,<sup>88-92,94-97,99-
218 106,108,115-117,129-134,139-141</sup> and Southern^{57,66-76,97,100-104,111-115,121,125,127} Africa (Table 1b, appendix
219 p 19). Study participants were mainly recruited from the general population of MSM<sup>32,43-45,47-
220 51,53,56-59,62-70,72-84,86,88-96,98-101,103,104,106,107,109-120,122,123,127-130</sup> (Table 1b). Various definitions of
221 MSM were used for study inclusion, with the period of sexual activity with men varying
222 between 3 months and lifetime and different types of sexual activity specified (e.g. anal sex
223 only, anal or oral, anal/oral/masturbatory). HIV prevalence (1-69%) and the proportion
224 ever/recently selling sex (11-82%) varied across studies. Face-to-face interviews were used
225 approximately three times more frequently than confidential interview methods (e.g. audio
226 computer-assisted self-interview). Most studies used respondent driven sampling (RDS;
227 N_s=30; Table 1e). Sample sizes ranged from 26 to 2,453 participants.

228 Only 22 studies reported on stigma,^{32,46,48,56,57,59,65,66,69,79,82-84,92,98,104,111,112,114,118,120,128-130}
229 including proportions of MSM who disclosed their MSM status to healthcare workers, or
230 family or had been blackmailed (Table 1c, appendix p 7-15). Most studies were conducted in
231 countries where same-sex relations were illegal (N_s=55).<sup>32,43-52,54-65,77-81,83,85-87,89-
232 100,103,104,106,108-111,113,116,118-125,128-130</sup> Forty-three studies were conducted in countries with
233 documented arrests related to consensual same-sex relations in 2014-2017 (Table 1d).<sup>32,43-
234 45,47-49,51,52,54-61,63-65,77,78,80,81,87,90-94,96-100,103,108-111,113,116,118,120-122,124,125,128-130</sup> Global anti-LGBT
235 legislation scores ranged from 0 to 12 and were lower in countries where same-sex relations
236 were legal than illegal (Table 1d, appendix p 16-18).

237 Study estimates, pooled estimates and 95% CI of all outcomes are summarised in Figures
238 2-8 and Table 2 and 95% PrI are presented in appendix p 20. Overall, the pooled proportion
239 of MSM ever tested for HIV was 61·0% (95%CI 56·2–65·7%, $N_e=81$, $I^2=98\%$), and was
240 highest in Southern and lowest in Northern Africa (Figure 2, appendix p 21-22). The
241 proportion of MSM tested in the past 12 months (pooled=46·2%,95%CI 39·6–
242 52·9%, $N_e=39$, $I^2=97\%$) was similar to the proportions tested in the past 6 and 3 months, and
243 was highest in Southern and lowest in Eastern Africa (Figure 3, appendix p 23-24). The
244 proportion of MSM HIV+ aware was much lower (pooled=18·2%,95%CI 13·0–
245 23·9%, $N_e=35$, $I^2=91\%$) especially in Eastern Africa (Figure 4, appendix p 25-26).

246 Overall, the pooled proportions of MSM living with HIV linked to care within 30 days of
247 diagnosis, ever engaged or currently engaged in care, were low and varied between 15·3%
248 and 40·4% (Figure 5). The overall pooled proportions of MSM living with HIV ever or
249 currently on ART were below 24%, and between 37-53% among MSM HIV+ aware (Figures
250 6-7). Overall, an estimated 24·7%, 34·4%, and 75·6% of MSM living with HIV, MSM HIV+
251 aware, and MSM currently on ART were virally suppressed, respectively (Figure 8).

252 HIV testing ever ($p=0\cdot0025$) and in the past 12 months ($p=0\cdot0015$) increased continuously
253 over time (Figures 2-3, appendix p 21-24), and by 14·8% and 17·9% percentage points,
254 respectively, after 2011 compared with before (appendix p 27). Only time trends in ever
255 tested differed between regions (year*region interaction: $p<0\cdot0001$), with greater increases
256 in Eastern and Western Africa, and significant within-county increases in Kenya, Uganda
257 and Nigeria (Figure 2, appendix p 28-29). Testing in the past 12 months increased
258 significantly over time in South Africa (appendix p 30). Post-2011, the proportions tested
259 (ever or in the past 12 months) were highest in Southern and lowest in Northern and Eastern
260 Africa, respectively (appendix p 27). The proportion of MSM HIV+ aware did not increase
261 over time overall ($p=0\cdot38$), or by region (year*region interaction: $p=0\cdot80$)(Figure 4, appendix
262 p 25-28), but increased in South Africa (appendix p 30). Too few estimates were available
263 for the other cascade outcomes to assess time trends.

264 In time-adjusted meta-regression, higher proportions of MSM tested ever and in the past 12
265 months were associated with living in Southern Africa($p=0\cdot0011$; $p=0\cdot040$) and less severe
266 penalties for same-sex relations($p=0\cdot0010$; $p=0\cdot00024$)(appendix p 21 and 23). Ever testing
267 was also higher with more protective($p=0\cdot0015$) and progressive($p=0\cdot016$) legislation, no
268 LGBT-related arrests from 2014-2017($p=0\cdot020$) and decreased by 2% (95%CI 1-4%) for
269 each point increase on the global anti-LGBT legislation index(continuous;
270 $p=0\cdot0026$)(appendix p 21 and 31-32). The magnitude of the association was sensitive
271 (approximately halved and no longer significant) to excluding all South African studies only,

272 but not to the exclusion of any single South African study (appendix p 31-32). Testing in the
273 past 12 months was also higher with less repressive legislation ($p=0.023$) and with the
274 lowest global anti-LGBT legislation index scores (categorical; $p=0.010$)(appendix p 23). In
275 subgroup analysis, differences in testing ever and in the past 12 months by global anti-LGBT
276 legislation score were reduced after 2011 (appendix p 33-35). In univariate meta-regression,
277 a higher proportion of MSM HIV+ aware was associated with not living in Eastern Africa
278 ($p=0.046$), less repressive legislation ($p=0.014$), less severe penalties for same-sex relations
279 ($p=0.00023$), and a lower global anti-LGBT legislation index (categorical;
280 $p=0.0050$)(appendix p 25).

281 Among the few studies reporting on stigma, testing ever and in the past 12 months were
282 higher with greater disclosure of MSM status to healthcare workers in time-adjusted meta-
283 regression ($p<0.0001$ and $p=0.034$, respectively)(appendix p 21-24). The proportion of MSM
284 tested in the past 12 months (time-adjusted meta-regression: $p=0.015$) and HIV+ aware
285 (univariate meta-regression: $p=0.031$) were higher with higher proportions of MSM being
286 blackmailed (appendix p 23-26). Other outcomes had too few estimates to assess
287 associations using meta-regression.

288 The influence of study quality was assessed for the three HIV testing and awareness
289 outcomes with ≥ 20 study estimates (appendix p 36-42). Pooled estimates of all three
290 outcomes differed with sampling method and were significantly higher in studies that did not
291 use a complex study design or did not use statistical adjustment for complex study design
292 (appendix p 21-26 and 40-42). Pooled estimates were also higher for studies specifically
293 designed to estimate the outcome of interest (ever tested), with less adequate response
294 rates (ever tested), that used more confidential interview methods (ever tested, tested in the
295 past 12 months), that adequately described their methods and/or basic data (tested in the
296 past 12 months), did not sufficiently describe their methods (MSM HIV+ aware) and with
297 study populations not representative of wider MSM (MSM HIV+ aware). Although not
298 statistically significant, higher rates of ever testing and HIV status awareness were observed
299 for studies with a quality score of 0 (appendix p 40 and 42).

300 There was no evidence of publication bias for the proportions of MSM tested ever or in the
301 past 12 months or HIV+ aware from funnel plots and Egger's asymmetry test (appendix p
302 43). Pooled proportions of MSM HIV+ aware were significantly higher for the subset of
303 directly reported study estimates than those self-calculated ($p=0.0045$; appendix p 42).

304 **DISCUSSION**

305 Our results suggest that levels of engagement in HIV testing and particularly treatment
306 cascade stages for African MSM remain sub-optimal, below those needed to achieve
307 UNAIDS 90-90-90 targets.

308 From 2011 onwards, only 50% of MSM reported testing in the past 12 months, 19% were
309 HIV+ aware, and 53% of MSM HIV+ aware were on ART. 76% of MSM on ART were virally
310 suppressed, suggesting that once on ART, MSM can achieve fairly high viral suppression
311 levels. However, since levels of diagnosis and ART access remain poor, levels of ART use
312 (24%) and viral suppression (25%) among all MSM living with HIV are critically low, meaning
313 HIV spread within these populations will continue.

314 We observed significant regional differences in HIV testing and status awareness. After
315 2011, levels of MSM ever tested, tested in the past 12 months and HIV+ aware were highest
316 in Southern Africa and lowest in Northern, Eastern, and Eastern Africa, respectively. The
317 greatest improvements in testing over time occurred in Eastern and Western Africa. These
318 differences may reflect different levels of expansion of community-based testing and national
319 HIV testing campaigns across regions.^{131,132} Further expansion of community-led services,
320 access to rapid and home-based testing, along with increased treatment support or
321 counselling from LGBT-friendly organisations, will be essential to engage more MSM with
322 HIV testing and treatment.¹³²

323 We found evidence of statistically significant negative associations between testing and HIV
324 status awareness and the severity of anti-LGBT legislation, which may, but do not
325 necessarily, reflect causal relationships. These appeared to be mediated by negative
326 associations between ever testing and a lack of protective or progressive legislation, or
327 harsher penalties for same-sex relations, and between recently testing/HIV status
328 awareness and repressive legislation or harsher penalties for same-sex relations. However,
329 the strength of the association between our anti-LGBT legislation index and ever testing was
330 influenced by South African estimates, which had the lowest anti-LGBT legislation scores.
331 Thus, other country-level factors (e.g. healthcare- or epidemic-related) may partly confound
332 this association.

333 Despite limited data availability, HIV testing and status awareness were lower in studies with
334 lower disclosure of MSM status to healthcare workers, consistent with studies reporting
335 associations between stigma and limited care cascade access.^{56,133} Training for healthcare
336 workers will be important to tackle the intersection of HIV-related stigma with discrimination

337 towards MSM and improve levels of testing and status awareness.¹³⁴ Consistent with other
338 studies, we observed a positive association between ever testing and MSM HIV
339 prevalence.¹³⁵ Higher prevalence could encourage MSM to test for HIV (as previous studies
340 show that low threat perception can impede testing) or reflect targeting of testing services to
341 more HIV-prevalent areas.¹³⁶

342 Our pooled estimate of testing in the past 12 months pre-2011 (overall 33%) agreed with the
343 2008 UNGASS estimate of 30% among MSM in sub-Saharan Africa (from only one country
344 however).⁹⁷ Available UNAIDS estimates of HIV status awareness among MSM in African
345 countries – based on unpublished and/or more recent data – tended to be higher than our
346 estimates, but UNAIDS ART coverage estimates for MSM living with HIV were mostly similar
347 to ours.¹² Our results suggest a worse situation for MSM in Africa than elsewhere. Our
348 cascade estimates for 2011 onwards are far below those from a study in six European and
349 Central Asian countries, which reported that in 2016 83%, 70%, and 63% of MSM living with
350 HIV were aware of their status, on ART, and virally suppressed,¹³⁷ respectively, compared
351 with 19%, 24% and 25% from our study. A recent literature review showed higher levels of
352 status awareness for high-income Western countries (72-100%) than we found, somewhat
353 higher levels (44%) for India, another low-income setting, but similar levels (20%) for Russia,
354 which enforces harsh anti-LGBT legislation.²⁵

355 There are marked differences in HIV testing and ART coverage for African MSM compared
356 with all men (see appendix p 44-46). Although levels of testing ever and in the past 12
357 months are consistently higher for MSM than all men across regions, self-reported HIV
358 status awareness and ART coverage are substantially lower among MSM than
359 corresponding estimates among men living with HIV (Mathieu Maheu-Giroux personal
360 communication and appendix p 46).¹³⁸

361 Our review has several strengths and limitations, partly due to data and study quality, which
362 may reflect the challenges of conducting research among key populations that face
363 substantial stigma.¹³³

364 We reported new pooled estimates for 44,993 MSM across five outcomes from studies
365 conducted between 2004 and 2017 and explored changes over time, by region and country.
366 We self-calculated additional study estimates, increasing the sample size and minimising
367 publication bias. We explored heterogeneity due to participant and study characteristics,
368 additionally assessing the influence of anti-LGBT legislation using a novel index. ILGA
369 publish the Rainbow Index for European countries¹³⁹, but to our knowledge no similar tools
370 exist for African countries. Despite increases over time, studies on the treatment cascade

371 among MSM in Africa remain scarce, particularly for Central and Northern Africa. Studies
372 were missing from 26 countries, 13 where same-sex relations are illegal. Therefore, our
373 overall pooled estimates may not be representative of MSM across Africa and may
374 misestimate engagement, especially for ART use and viral suppression, which were based
375 on very few estimates. Small numbers of studies in Central and Northern Africa limit our
376 ability to assess regional levels and trends in HIV testing.

377 Heterogeneity across study estimates was substantial and could only be explored in meta-
378 regression for the outcomes with the most study estimates (ever testing, testing in past 12
379 months, HIV+ aware). Not all studies reported key participant characteristics including age,
380 HIV prevalence and selling sex, with stigma the most poorly reported variable. Future
381 studies should report on stigma alongside testing and treatment outcomes.

382 Our analysis included studies of generally moderate quality, and reporting biases were
383 possible as most outcomes were self-reported, and most studies used non-confidential
384 interview methods. Pooled estimates were influenced by study quality and in particular
385 tended to be lower for studies that adjusted for complex study design (e.g. weighted RDS),
386 with less confidential interview methods (testing outcomes) or with higher quality scores
387 (albeit not significantly). Under-reporting has been previously documented among African
388 MSM, for example in HPTN 075, 22% of MSM living with HIV self-reported a positive status,
389 however ARVs were detected in 58%.¹²¹ One study in Uganda found that approximately half
390 of virally suppressed MSM (likely due to suppressive ART) reported not knowing their HIV-
391 positive status.³² Thus, our pooled estimates may underestimate true levels of status
392 awareness and ART use. Obtaining representative samples of MSM is difficult, even with
393 RDS sampling, with samples often biased towards younger, more visible MSM.¹⁴⁰ However,
394 our pooled estimates did not differ by mean age. Many of the RDS studies included here did
395 not report weighted estimates, potentially, but not necessarily, reducing their
396 representativeness.¹⁴¹

397 Included studies used varied definitions of MSM and most did not disaggregate TGW from
398 MSM, which however did not influence pooled study outcome estimates. However, it would
399 be preferable in future to provide disaggregated estimates to gain a better understanding of
400 the health needs of TGW. There was no evidence of publication bias for any outcome except
401 status awareness, and only in subgroup analysis comparing directly reported and self-
402 calculated estimates.

403 Our anti-LGBT legislation index only captures information about legislation, not how
404 legislation is implemented. Only recent arrests after 2013 were available to measure

405 implementation, and for few African nations,²⁰ therefore we may not have fully captured the
406 influence of changes in legislation implementation. More implementation data is needed.
407 Nonetheless, our novel anti-LGBT legislation index reflected complex African legislation over
408 time and enabled detailed analysis of our data in a legal context. Although no other
409 measures or indexes are currently available specifically for Africa, our index correlates well
410 with the recent global Homophobic Climate Index (data not shown).¹⁴²

411 Engagement with the HIV treatment cascade among MSM in Africa remains low, despite
412 recent improvements in HIV testing. Lower testing and status awareness levels were
413 associated with more hostile legislation. More studies are needed on HIV testing and
414 particularly the HIV treatment cascade for MSM across Africa, especially Northern and
415 Central Africa. Future studies should use confidential interview methods to reduce reporting
416 biases and collect standardised stigma data.

417 **Contributions**

418 MCB, JE, KM, ED and JS conceptualised this review and planned the analysis. JS, ED and
419 RS conducted the search and independently performed all stages of screening. JS and ED
420 independently extracted data, and JS conducted all analyses. KM double-checked data
421 extraction and checked the data analysis, with input from MCB. JS, ED, KM and MCB
422 interpreted the results and conceptualised the first draft of the review. JE and CB made
423 significant intellectual contributions to the interpretation of the results and edited the
424 manuscript. All authors read and approved the final version of the manuscript.

425

426 **Declaration of interests**

427 We declare no competing interests.

428

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435 our review with levels among all men.

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